Enhanced inherent strain method applied to a “bridge-like” structure

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ABSTRACT

Prediction of residual stresses and part distortion is decisive to ensure the quality of metallic parts manufactured by Additive Manufacturing (AM). Therefore, distortion prediction and compensation by means of numerical methods has become a standard in the way of achieving the right-first-time objective.

It is well known that the most reliable results are obtained by high-fidelity thermo-mechanical analysis but nowadays computational time is unacceptable yet. Substantial efforts are being made to develop advanced Finite Element (FE) parallel frameworks to solve this problem at part scale in a reasonable amount of time [1]. However, simplified modelling assumptions are still necessary to reduce computational time.

The inherent strain method is the most computationally efficient and widely implemented simplified methodology. The original inherent strain method [2] and its calibration strategies [3] have shown to be valid for obtaining qualitatively correct but partially accurate distortion predictions. The lack of accuracy is specially noticeable in those geometry-printing configurations where bridging effects are present.

In this regard, several attempts have been made to enhance this methodology by feeding the inherent strain method with macro-level heat transfer analysis. Hence, non-uniform and time dependent thermal strains can be considered while the original problem is solved.

In this study, the importance of employing an enhanced inherent strain method for capturing better distortion phenomena is shown. Both the original and the enhanced inherent strain techniques have been applied to a ”bridge-like” part made of Ti64. A simple case has been printed using a SLM280 machine and 3D scanned in order to conduct the correlation analysis between numerical and experimental results.

REFERENCES

[1] E. Neiva, S. Badia, A. F. Martín, M. Chiumenti, A scalable parallel finite element framework for growing geometries. Application to metal additive manufacturing, ArXiv e-prints (Oct. 2018). `arXiv:1810.03506`.

[2] N. Keller, V. Ploshikhin, New method for fast predictions of residual stress and distortion of am parts (2015).
URL `https://sffsymposium.engr.utexas.edu/sites/default/files/2014-096-Keller.pdf`

[3] I. Setien, M. Chiumenti, S. van der Veen, M. S. Sebastian, F. Garciandía, A. Echeverría, Empirical methodology to determine inherent strains in additive manufacturing, Computers

& Mathematics with Applications (2018) –doi:10.1016/j.camwa.2018.05.015.
URL https://www.sciencedirect.com/science/article/pii/S0898122118302839